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Life Cycle Assessment and environmental sustainability in the food system

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Abstract

In a globalized market where the national and international competition is growing it is important, for the Food System, to be able to focus on innovative strategies concerning the adoption of "sustainable" practices to represent an element of distinction and added value.

Sustainability, in its widest meaning of well-being sustainability, can be analyzed considering four visions: environmental, economic, social and generational.

In this paper, starting from a literature review, we will proceed to a theoretical analysis of the impact of the food system on the environment and of actions that, over time, have attempted to reduce it.

In a second phase we will focus on the olive oil sector, which although, to date, does not include environmental externalities regarded as most critical, it is good to start to reconsider it in a new perspective.

This will ensure that olive oil production can gain the competitive advantage of sustainability either to win the global competition for fielding competitive strategies, or contribute to territorial well-being sustainability.

It will be used as a theoretical reference model Life Cycle Assessment (LCA) which will set a complete picture of the interactions with the environment of the olive oil sector. The LCA considers externalities of each phase of olive oil production towards human health, ecosystem quality and resource depletion and also economic and social impacts.

Finally, we will apply the LCA model to same Italian case studies in order to evaluate their environmental performance.

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Keywords: Food system, well-being sustainability, Life Cycle Assessment, olive oil sector, Environmental Product Declaration.

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1. Introduction: The environmental impact of the agri-food system

The dissemination of the concepts of sustainability, sustainable food systems and sustainable development has continued since the publication of the Brundtland Report "Our Common Future", in 1987, the definition of which is: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs "(WCED, 1987).

In this definition, it should be noted in particular that you do not really speak about the environment as such, but it refers to the welfare of the people, and therefore also the quality of the environment plays a key role. It highlights an ethical principle: the responsibility to the generations of today towards future generations, then touching at least two aspects of environmental sustainability: that of the maintenance of resources, and their ability to replicate, and the environmental balance of the planet.

The challenge that the Food System will face is to produce enough safe food, and meet the new demands of the consumers without a negative impact on natural resources and the environment in general. A full assessment of the environmental impact of a food system covers the entire food supply chain, which is the primary production stage, the stage of industrial transformation, the distribution phase. In particular, of the most obvious phenomena of environmental impact of agriculture are to be mentioned the loss of biodiversity and the genetic homogeneity of crops[1]. Despite these phenomena reveal that the primary production contributes more than any other activity to the environmental impact of the entire food supply chain, the phase transformation, distribution and domestic consumption still represent a significant impact factor, in terms of energy intensity, use of water and production of waste.

To date, however, there is a lack of the ability to look at the Food System as a production unit that structurally interacts with its environment, both in terms of production of goods and services from the aspect of resource use; In fact, an approach that includes evaluation of externalities, both positive and negative, is still not widespread.

Sustainability understood as the commitment of the entire food chain to consumers and future generations, requests that all stakeholders of the Food System have a greater commitment on the adoption of new models, new actions, new technologies and new methods aimed at sustainability, in environmental terms.

That is why the world of research and politics are committed, through the adoption of a more comprehensive (holistic approach) of the Food System, in the study of solutions and strategies to minimize the impact of the same on the environment, ensuring and safeguarding the replicability of the stock of natural capital[2]. The “sustainable” production can be applied in the early stages of the agricultural sector with the use of techniques of integrated and organic production; during the phase transformation, however, by the techniques of reduction of energy consumption, water, and greater attention to the incidence of packing and shipping.

In this scenario, biodiversity conservation and the restoration and protection of ecosystems must become shared priorities, in terms of investment in natural capital, which require radical changes in patterns and practices of economic development around the world. Other actions include: the adoption of sustainable production methods, the promotion of an efficient energy system, the creation of short food supply chains, the minimization of losses and waste at all stages of the Food System, the protection of traditional knowledge and finally a fair and adequate education aimed at building a sustainable food future for all generations. The improvement of environmental sustainability is a challenging process and continuous need for extensive knowledge and complex decisions. It is necessary, to this end, to have tools for both dynamic and efficient technical choices for the calculation of indicators.

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[1] According to FAO estimates, 75% of the varieties of agricultural crops has disappeared and three quarters of food from around the world comes from just 12 plant species and five animal species.

[2] Natural capital is made up of services, supported by the presence and activity of living organisms, that natural ecosystems are able to provide: climate regulation, stabilization of the water cycle and the mitigation of destructive events extremes as persistent drought or floods or storms ruinous, nutrient recycling and water purification, preservation and regeneration of soils, pest control and other vectors of human disease, the use of plants and animals for the production of new drugs, the collection of materials of primary interest as a source of food for human populations (Cesaretti GP et al, 2013).

2. Food system and Environmental Product Declaration

In an environmentally sustainable key, the production process is increasingly seen as a competitive advantage for those companies wishing to meet the growing demands of environmental responsibility on the part of the consumer[3]. For this, the search for new strategies and actions to ensure compliance of environmental resources is growing in many areas, but even more in the food industry. This is due to its specific vulnerability to certain risk factors (such as climate), and for the particular importance of the issues of quality and safety of products.

Energy conservation, climate change, water use, land use, are some examples of themes designed to influence future production processes.

The production of quality food obtained environmentally sustainable, in fact, today, as well as being a requirement of the consumers, is also important for farmers, aware that greater attention to environmental problems can lead to substantial energy savings, resource of materials, resulting in economic benefits. Here, then, we begin to discuss what could be the most appropriate means, both for the internal agricultural enterprises, renewal of manufacturing processes aimed at improving environmental performance, and for the possibility of attributing value to the environmental objective of the products, recognizable and marketable (Ambiente e Territorio, 2014).

Today more than ever, it can be said that the environmental impacts associated with the food activities are intrinsically linked to food security both locally and globally. Agricultural production, the transformation of the intended use of the area, processing and food processing, production of packaging and, last but not least, transport is among the human resources activities that contribute significantly to global climate change (Fiore M., 2009).

In this context, the use of so-called eco-labels is to demonstrate the functional responsibility of a company rather than the use and management of an "environmentally sustainable" resource. The tools already available, in this sense, are the environmental product declarations, governed by the UNI EN ISO 14025[4]. The international standard UNI EN ISO 14025: 2010 establishes the principles and specifies the procedures for the construction of eco-labels based on established parameters, which contain a quantification of the environmental impacts throughout the life cycle of the product, calculated by a method of Life Cycle Assessment.

The Life Cycle Assessment method is internationally standardized (ISO 14040 and ISO 14044) for the evaluation of environmental loads and resources consumed over a life cycle of goods and services.

Through the application of the system governed by that provision, any company in any industry can get the label EPD (Environmental Product Declaration) and spread the potential environmental impacts of its products throughout their entire life cycle[5].

The Environmental Product Declaration (EPD) is a document that allows you to communicate comparable and credible objectives, regarding the environmental performance of products and services. This statement “for information purposes only” does not contain evaluation criteria, preferable or minimum levels that the environmental performance should respect. The EPD should be developed using the Life Cycle Assessment (LCA) as a methodology for the identification and quantification of environmental impacts.

The EPD is applicable to all products or services regardless of their use or placement in the production chain, classified into well-defined groups. The classification into groups allows comparisons to be made between products or services functionally equivalent. It is verified and validated by an accredited independence that ensures the credibility and veracity of the information contained in the LCA study and in the declaration. Objectivity, comparability and credibility are therefore the main features on which are based environmental product declarations and the system that supports them.

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[3] The so-called "consumer" is the real key to change. Can consolidate the industrial system or implement a radical change of habits, behaviors and priorities, opening the way for a new agriculture based on sustainability. Consumer choices have a significant impact on the entire agricultural and food system. Consumers have great power: through increased awareness of the value of their choices. (Slow Food, 2013).

[4] Among the different systems of environmental labeling, that, to date, has been more successful, is the International EPD consortium (IEC), international adoption of the Swedish program (Swedish Environmental Management Council), which is also joining Italy.

[5] To date, this system has a total of 129 certifications of which the largest number just in Italy (less than 58, against 49 in Sweden).

The EPD is a communication tool designed to give concrete answers to the needs expressed by businesses to communicate to the market, in real time, the environmental improvements of our products and services, providing the necessary scientific guarantees of credibility. The information only allows the EPD to provide adequate information in order to make assessments related to the economic, geographic and social context in which it operates and with environmental policies and pursuing development. The EPD structure, based entirely on international standards ISO, also allows a system to adopt the marketability of the recognition beyond the national context. Placing the perspective of the user information the EPD is a useful tool for the implementation of sustainable procurement policies, green procurement, which makes the environment variable as a criterion of choice, preferential consumer responsible.

3. Life Cycle Assessment methodology

The Life Cycle Assessment considers the environmental impacts of the case examined in relation to human health, ecosystem quality and resource depletion, also considering the economic, financial and social impact (Curran MA., 1996). The objectives of the LCA are to form a complete picture of the interactions with the environment of the wine products, helping to understand the environmental consequences caused directly or indirectly, and then provide the information needed to define the environmentally sustainable behaviors and identify opportunities for improvement in order to achieve the best solutions to intervene on the environmental conditions.

It is the main operational tool of "***Life Cycle Thinking***". The LCT is an objective method of evaluation and quantification of the energy and environmental and potential impacts associated with a product / process / activity along the whole life cycle, from raw material acquisition to the end of life ("from the cradle to Tomb"), (Rebitzer G., et al. 2004). The importance of this technique lies mainly in its innovative approach that consists in evaluating all stages of a production process as related and dependent.

LCA is therefore a comprehensive analysis of the environmental impacts of a product throughout its entire life cycle, from the extraction of raw materials to manufacturing, packaging, transport and use, to disposal of waste. It is useful to quantify the use of resources consumed (inputs such as energy, raw materials, water) and related environmental emissions (output of air, water and soil), assessing the risk, because the real impact of these emissions depends on when, where and how they are released into the environment. The LCA studies include four phases:

i. Goal Definition and Scoping;
ii. Life Cycle Inventory Analysis – LCI;
iii. Life Cycle Impact Assessment – LCIA;
iv. Life Cycle Interpretation and Improvement.

During the first phase are defined the purpose of the study, the scope, the functions of the system studied, the functional unit, the boundaries of the system, the characteristics of the data, assumptions and limitations, the calculation method used.

The identification and quantification of the flows into and out of the system under analysis throughout its life are the activities of the second phase. In it, therefore, are identified and quantified the consumption of resources (raw materials, water, recycled products), energy (heat and electricity) and emissions to air, water and soil.

The LCIA phase is the study of the environmental impact caused by a manufacturing process or from a business, made through the use of some aggregate indicators of international use that help quantify impacts and compare alternative processes or products. The impact analysis is divided into four phases: classification, characterization, standardization and evaluation. These last two steps are not mandatory for the application of the system.

Finally, the phase LCII concerns the interpretation of the results, the identification of critical environmental issues and, at the same time, highlighting the potential for technical and managerial improvement of the life cycle of the product being studied.

We proceeded to apply the methodology of LCA to a company of the olive sector, in order to assess the environmental impact.

4. Olive oil sector and environmental impact

Istat published on September 18, 2014 data related to quality food products which shows that Italy is a reference point for outstanding products "Made in Italy" in Europe and in the world.

With 261 products (December 2013) Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Specialty Guaranteed (TSG) conferred by the European Union (EU), Italy is the country that has the largest number of excellent food.

The sectors with the highest number of awards are fruit and vegetables and cereals (101 products), cheese (47), the extra virgin olive oil (43) and meat preparations (37). Fresh meat and other sectors include, respectively, 5:28 specialties.

This paper focuses on the olive oil sector, which plays a particularly important role especially in the regions of the South where almost 90% of the national production is concentrated. The sector of the olive oil in Italy is a major agricultural sector for both production value and for socio-economic importance of this activity in terms of employment. Sector policies in recent years have been designed to achieve two main objectives:

a) the lack of a commercial qualification of most of the national production, that is, the one coming from the southern regions.
b) improving the environmental sustainability of olive products and by-products derived from it.

Environmental issues arising from the use of intensive traditional and modern culture techniques of the olive trees can be associated to soil erosion, depletion of scarce water resources, pollution due to the use of agrochemicals and loss of biodiversity. Soil erosion is one of the most serious environmental impacts associated with the intensive cultivation of olive trees. The erosion reduces the productive capacity of the soil and, therefore, it undermines the productivity, and this translates into a greater use of fertilizers. Making some changes to the methods of cultivation, these problems can be tackled. For example, soil erosion can be limited by maintaining a grass cover at crucial times of the year or by plowing shallower. The construction or repair of terraces with dry stone walls. The productivity of the olive trees increases considerably with irrigation, to which recourse is made especially for the table varieties Water is also necessary in intensive plantations with a high density of olive trees, and serves to improve the effectiveness of fertilization and pruning. Biodiversity is generally high in the olive groves planted in the traditional way. The intensive methods of cultivation introduced with the aim of increasing the production (in particular, the use of plowing and mechanical recourse extended to insecticides and herbicides) have had a negative impact on flora, surface and populations of insects, reducing diversity and number. Among other impacts attributable to the sector is the indiscriminate use of numerous products, which has sometimes resulted in an increase in the number of weeds due to the elimination of their natural enemies. Excessive herbicides treatments are also the cause of bacterial wilt of some of the olive plantations. The energy consumption is another environmental problem, especially regarding the intensively cultivated crops, which require a relatively large mechanical plowing. They are in the process of testing culture techniques more environmentally friendly, such as the one involving the use of waste pruning of olive trees: the cut branches will no longer be burned, but used as organic fertilizer. This procedure allows further processing of the waste for use as biofuels.

4.1. Life Cycle Assessment methodology: case study "Azienda Agricola Paola Orsini"

The "*Agricultural company Orsini"*[6], situated in the heart of the Lepine Mountains, covering an area of about 50 hectares, with about ten thousand olive trees, alternated with almond and citrus trees and Mediterranean scrub, all located on little high ground overlooking partly towards the Tyrrhenian Sea. The geographical location makes this area particularly suited to olive growing and, in many ways, it makes the product the only one in the world: the plants are, in fact, placed on hills, about 200 meters above sea level, and exposed to the sun and ventilation , in an area where the soil is mostly rocky. The predominant *cultivar* is the Itrana olive, which is native of this area, the raw

[6] The company is located in Lazio, in the municipality of Priverno in the province of Latina.

material for the production of monocultivar Itrana oil[7]. Fully respecting the environment and above all to preserve this little piece of paradise, the company converted the ordinary cultivation in organic agriculture: the cultivation takes place in accordance with nature's rhythms and laws. The transformation process begins with the olive harvest, in October and November, and continues with their transport in the farm oil mill, for the milling. This is equipped with two innovative decanter, which effects the extraction of oil, an authentic green gold, without the aid of the centrifugal separator, which could alter the physical, chemical and organoleptic characteristics. Thus this process ensures a high quality of the product, also thanks to a very low acidity.

Thanks to the promotion of the territory and the respect for its characteristics, to the entrepreneurial skills and to a strong determination, the Orsini farm has obtained several awards, including the prestigious Ercole Olivario as the best Italian oil in the year 2011- 2012 and 2012 -2013, "Best Organic Oil", "Best oil with a high content of tocopherols and polyphenols", the first place in the category "Intensely fruity Colline Pontine DOP ", the second place in the category "Intensely fruity extra virgin oil"; and other rewards from authoritative magazines and guides such as the magazine "Gambero Rosso", and "Slow Food".

4.1.1. Life Cycle Assessment methodology: application and results

The LCA studies includes four principal phases: Goal Definition and Scoping; Life Cycle Inventory Analysis - LCI; Life Cycle Impact Assessment - LCIA; Life Cycle Interpretation and Improvement. In the application of the methodology the main 4 phases were divided into sub-steps, as indicated below.

Goals and system setting phase. Identification and assessment of the main impacts and environmental criticalities associated with the production techniques and to the identification of the processes that cause the greatest environmental impact, in order to propose technological and / or operational possibilities having a reduced impact. The reference product is the extra-virgin olive oil Orsini.

System definition phase. System chosen: olive grove where regularly are realized some operations of soil tillage, irrigation, fertilization, pesticide application and trees pruning. The harvested olives are then transported to the mill, where takes place the milling. The system was then divided into two subsystems Cultivation and Milling.

System boundaries definition phase. The study of olive oil covered: agricultural production, refinement industry, storage, packing.

Functional unit definition phase. Functional unit chosen: 1 liter of olive oil produced.

Conceptual model definition phase. Determination of the main processes - determination of input and output to / from each process - quantification of each input / output.

Data collection and implementation in SimaPro phase. It proceeded to the development of a questionnaire administered to the owner, Mrs. Orsini. In SimaPro each process has been defined through three types of information included in so many sections: "documentation" that contains several comment fields and the characteristics of data quality; "Input / output", that contains all the elementary streams and the products into and out from the process; "Description of the system", that provides a detailed description of the system.

Using the function "analyze", the software has been able to calculate the inventory of the system by building the process tree and by tracing all the references between the different process, in order to evaluate the emissions flows, the resources and the wastes for the reference unit chosen.

Based on the simulations realized in relation to the operations of cultivation and olives processing into oil by pressing, can be deduced the following conclusions regarding the technical solutions adopted by the farm Orsini intended to the environment safeguard and protection by ensuring its replicability.

In fact the farm Orsini, considered the results of the LCA model, has intervened on both the agricultural phase and on the industrial one. To this end, *for the implementation of the olive harvest, the company has endorsed the use of electric ecological facilitators, whose start-up is via rechargeable power-operated batteries, with a low*

[7] For the protection of this excellent type, whose presence is detected only in the hills of the Province of Latina, has been created the area DOP, Protected Origin Designation "Colline Pontine".

consumption. These facilitators, produced by the firm Pellenk, are accompanied by related saws suitable for pruning. As regards the work inside the mill the movements of binz, containing the olives, are carried out with electric forklifts, so with no oil, to avoid the contamination of the olives from the hydrocarbons. The hot water system, for oil production, is produced by a depleted pomace boiler which is produced inside the plant. The oil machines are low energy and low consumption of process water. The water supply comes from an artesian well located a few meters from the building. The by-products, namely vegetable water and depleted pulp (virgin pomace), are assigned for the 80% at a plant biomass.

5. Conclusion

The environmental impact of the food system occurs at different levels in terms of both quality and quantity. Certifications meet two objectives: verify the compliance and the quality of systems and processes; help to provide adequate information to consumers and other stakeholders.

To carry out, therefore, a proper evaluation, it is necessary to apply recognized and internationally comparable methods. This is to provide manufacturers data, information and media to produce in a sustainable manner; and offer consumers transparency on production processes through the traceability from farm to fork.

To this end, in this work it was intended to use the methodology of Life Cycle Assessment governed by UNI EN ISO 14040, to a practical case. The application of the method Life Cycle Assessment has highlighted and located the opportunities for reducing environmental impacts related to the life of the product chosen (olive oil); support the farm Orsini about decisions related to interventions on processes, products and activities; disseminate and promote the low environmental impact of the life cycle of the oil produced in the farm; evaluate and compare the effects linked to different environmental and resource management policies.

References

Ambiente e Territorio, 2014.

Cesaretti G.P., Viola I., Misso, R., Borrelli IP., 2013. Green society - a conceptual framework of sustainability from a territorial perspective. Quality - Access to Success, vol. 14, p. 50-67.

Curran MA., 1996. Environmental life-cycle assessment. The International Journal of Life Cycle Assessment.

FAO 2011. Global food losses and food waste: extent, causes and prevention.

Fiore M., Breedveld L., Arrivas Bajardi C., Giaimo L., Notaro A., 2009. Certificazione ambientale di prodotti agroalimentari.

UNI EN ISO 14040:2006, Gestione ambientale - Valutazione del ciclo di vita - Principi e quadro di riferimento

UNI EN ISO 14044:2006, Gestione ambientale - Valutazione del ciclo di vita - Requisiti e linee guida

Rebitzer G., Ekvallb T., Frischknechtc R., Hunkelerd D., Norrise G., Rydbergf T., Schmidtg W.-P., Suhh S., Weidemai B.P., Pennington D.W., 2004. Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications. Environment International Volume 30, Issue 5, July 2004, Pages 701–720

Slow Food 2013. Il benessere animale secondo Slow Food. Documento di posizione

Viola I., 2014. “The Made in Italy "beyond the growth": the food system green oriented”. Rivista di Studi sulla Sostenibilità, Vol. 2/2014, ISSN 2239-1959.

Viola I., Marinelli N. 2014. “Green orientation in the food industry and labour market”, Supplement of “Quality-Access to Success” Journal, Vol. 15, S1, March 2014, ISSN 1582-2559.

World Commission on Environment and Development.1987. Our Common Future.